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DESIGN, DEVELOPMENT AND DELIVERY OF
75VA INTEGRATED STATIC INVERTER

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SECTION II

TECHNICAL DISCUSSION

4 pages
A. Progress Report ~~for Month of~~ Feb. 19671. Summary

Production model inverter #1002 was shipped to NASA on February 27, 1967, as a replacement for inverter #1001, which was returned to T.I. on February 21. Inverter #1002 has been completely tested over the ambient temperature range of -25°C to $+100^{\circ}\text{C}$.

Delivery of the last inverter, (#1003)) is being held up because of the lack of an L-164 power transistor. The basic problem is a shortage of ceramic piece parts required to build packages for the L-164. A secondary problem is that the L-164 yield has decreased by the tightening of a secondary breakdown test spec deemed necessary for improved reliability.

The ceramic order is being expedited and delivery of the final inverter is expected during the last week of March.

2. Progress Report on Subsectionsa. System

A circuit modification has been made to inverters #1001 and #1003 (and should be made to #1004) for increased reliability.

The modification is the addition of two small TI-252 diodes to the low level printed circuit board (see D 11 and D 12 in Figure 1).

The diode modification is deemed important because it in effect reduces the "cross over" time of the inverter from the constant voltage mode to the constant current mode. In doing so it reduces the magnitude and duration of a high power transient which occurs in the L-164 (switching regulator power transistor) whenever an abrupt "cross over" is necessary. The two worst case conditions have been found to be, (1) when turning inverter

on initially into a short circuit and, (2) when the inverter is operating unloaded in the voltage mode and suddenly has its outputs shorted.

Figures 2 and 3 show the transient conditions that occur in the L-164 for these two "worst case" conditions before and after the diode modifications.

The time required for the inverter to cross over from voltage control to current control depends upon the initial voltage on C15 (Figure 1) and its charging time constant. The addition of diodes D11 and D12 effectively provide C15 with an initial bias voltage from a low impedance source, Z5.

Diodes D11 and D12 only supply C15 with a bias voltage as long as the current sense voltage from D4 is low. As the AC output current reaches its limited value, the current sense voltage from D4 becomes large enough to reverse bias D11 and D12, thereby removing the bias source when it is no longer needed.

b. Power Transistors

Three L-164's are in QRA for mechanical evaluation as of March 2. Sufficient ceramics for 40 L-164's are overdue. Within three weeks of their receipt enough L-164's to insure completion of the contract should be available.

c. I/C Arrays

The last single chip Johnson Counter material was processed and probed.

All of the single chip Johnson Counter material has been processed and evaluated. The results were negative. No operating arrays were obtained. No more effort will be expended in this area.

d. Final Report

The final report is in publications for art work and rewrite.

B. Current Problems and Corrective Action

No problems.

C. Work to be Performed During Next Reporting Period

1. System

- a. Deliver one remaining inverter.
- b. Complete final report.

2. Power Transistors

- a. Build and test additional L-164's.

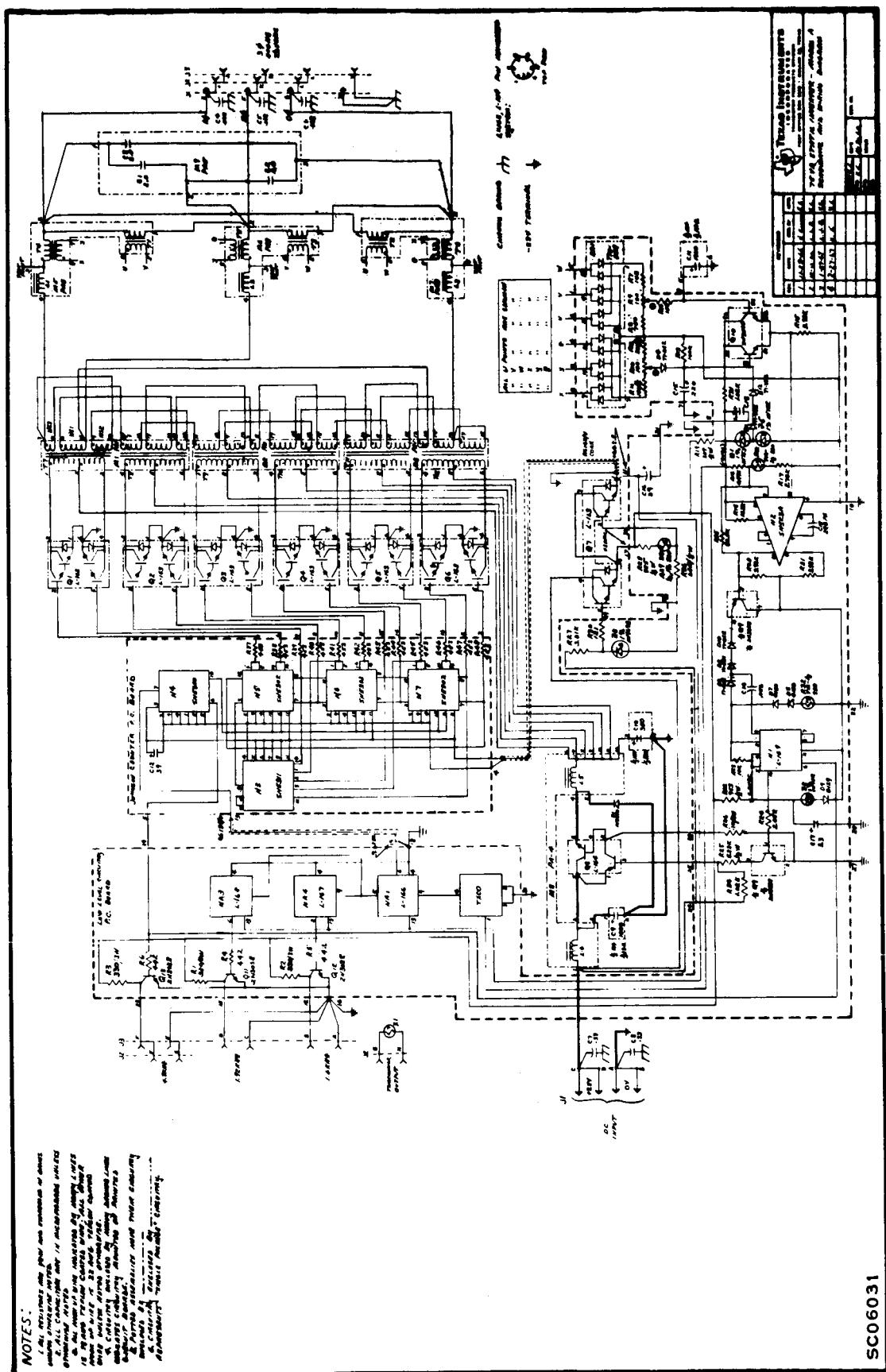


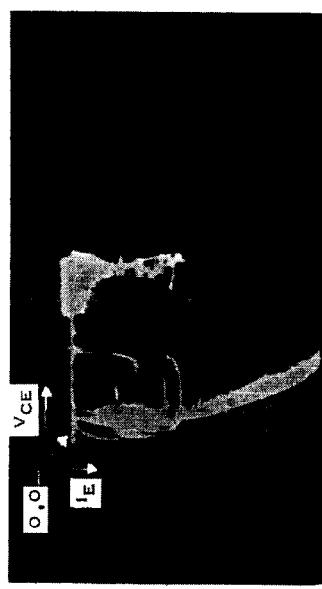
Figure 1. 75 VA Static Inverter — Model A — Schematic and Wiring Diagram



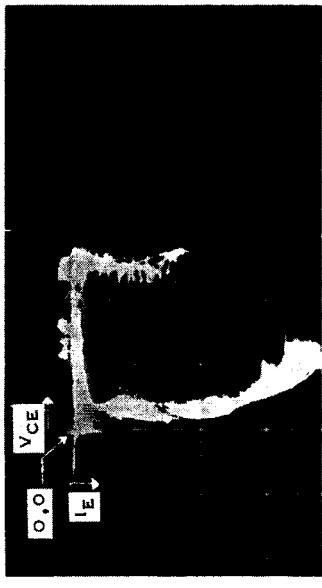
TRANSIENT EMMITTER CURRENT IN L-164
TURNING INVERTER ON INTO 3φ SHORT



TRANSIENT EMMITTER CURRENT IN L-164
SWITCHING FROM NO LOAD TO 3φ SHORT



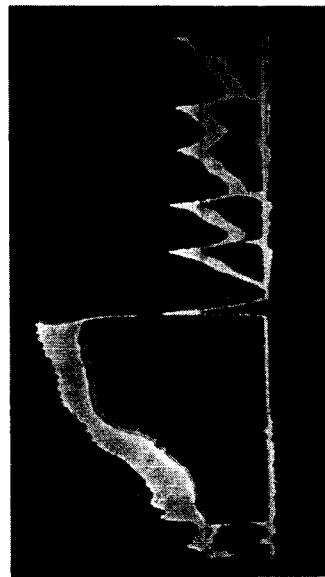
TRANSIENT I_E-V_{CE} PLOT OF L-164
TURNING INVERTER ON INTO 3φ SHORT



TRANSIENT I_E-V_{CE} PLOT OF L-164
SWITCHING FROM NO LOAD TO 3φ SHORT

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Figure 2. Transient Conditions in L-164 Before Diode Modifications



10 ms/DIV

TRANSIENT EMMITTER CURRENT IN L-164
TURNING INVERTER ON INTO 3 ϕ SHORT

10 ms/DIV

TRANSIENT EMMITTER CURRENT IN L-164
SWITCHING FROM NO LOAD TO 3 ϕ SHORT

10 V/DIV

TRANSIENT I_E - V_{CE} PLOT OF L-164
TURNING INVERTER ON INTO 3 ϕ SHORT

10 V/DIV

TRANSIENT I_E - V_{CE} PLOT OF L-164
SWITCHING FROM NO LOAD TO 3 ϕ SHORT

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Figure 3. Transient Conditions in L-164 After Diode Modifications

PARTS LIST - 75VA STATIC INVERTER
3-3-67

TABLE 1

| <u>Component Designation</u> | <u>Description of Components</u> | <u>Manufac-turer</u> | <u>Comments</u> |
|------------------------------|--|----------------------|--------------------|
| Q1-Q7 | L-163, Dual Power NPN Darlington Transistor, 6 Pin Stud Package | TI | Developmental Item |
| Q8 | L-164, Dual Power NPN-PNP Transistor, 6 Pin Stud Package | TI | Developmental Item |
| G1 | G1, Isolated Common Terminal | TI | Developmental Item |
| D1 | 1N3890, 100V, 12 Amp Fast Recovery Rectifier, DO-4 Type Package | TI | |
| C4-C6 | K1G33K-D2, .033 uf, 100 VDC, *10% Polycarbonate Capacitor | EIPAC | |
| C7-C8 | 196P33491T15, .33 uf, 100 VDC, *10% Metal Clad Capacitor | Sprague | |
| X1 | G-663 Thermistor (NASA Part #50M10346) | FEIC | |
| M4 | PA-2, Potted DC Filter Capacitor Assembly C9 202D108X0050A5, 50 VDC, 1000uf *20%, Sprague Tantalum Capacitor | TI | Developmental Item |
| C10 | 202D357X9150A5, 150 VDC, 350 uf *10%, Sprague Tantalum Capacitor | | |
| C11 | 202D198X9015A2, 15 VDC, 1900 uf *10%, Sprague Tantalum Capacitor | | |

| <u>Component Designation</u> | <u>Description of Components</u> | <u>Manufac-turer</u> | <u>Comments</u> | <u>Developmental Item</u> |
|------------------------------|---|----------------------|-----------------|---------------------------|
| M1, M2, M3 | PA-1, Potted Power Transformer Assembly Two Transformers: Cores-Magnetics 52026-2S Tape Wound Toroids, PRI. 180T, SEC. NS1 = 120T, NS2 = 90T, NS3 = 30T. All wire is #23 H.F. | TI | | |
| M5, M6, M7 | PA-3, Potted Inductor Assembly One AC Choke 1mh, 63 Turns, #18 H.F. Core: Magnetics 55927-M4 Powdered Iron Toroid | TI | | |
| M8 | One Voltage Sense Transformer Core: Magnetics 52176-2A, Tape Wound Toroid, PRI. 900T #36 H.F., SEC. 200T, #34 H.F. | TI | | |
| | One Current Sense Transformer Core: Magnetics 52000-2A Tape Wound Toroid PRI. 2T #16 H.F., SEC. 500T, #32 H.F. | TI | | |
| M9 | PA-4, Potted DC Choke Assembly L-4 ~ .265mh, 41 Turns, #13 H.F. Core: Arnold W110168-3 Powdered Iron Toroid | TI | | |
| | L-5 ~ .8mh, 54 Turns, #13 H.F. Core: Arnold W-108281-3 Powdered Iron Toroid | TI | | |
| | PA-5, Potted AC Filter Capacitor Assembly 3 Capacitors: C1', C2', C3'. K1G205J-H1, 1uf, 1100VDC, *5s Elpac Polycarbonate Capacitors | TI | | |

Low Level Circuitry P.C. Board

| <u>Component Designation</u> | <u>Description of Components</u> | <u>Manufacturer</u> | <u>Comments</u> |
|------------------------------|---|---------------------|--------------------|
| TXCO | X-1617706-1, 2.4576 mc Temperature Compensated Crystal Oscillator | Bendix | Developmental Item |
| N1 | L-166, Integrated Circuit 8 Stage Ripple Counter Array | TI | Developmental Item |
| N3 | L-168, Integrated Circuit ÷ 10 Flip-Flop Array | TI | Developmental Item |
| N4 | L-167, Integrated Circuit ÷ 12 Flip-Flop Array | TI | Developmental Item |
| N1 | L-169, Integrated Circuit Variable Duty Cycle One-Shot; Mask Modification of SN5380 | TI | Developmental Item |
| N2 | SN523A, Integrated Circuit Differential Amplifier | TI | |
| Q9 | 2N3838, Dual PNP-NPN Transistors in TO-89 Package | TI | |
| Q10 | 2N3044, Dual NPN Transistors in TO-89 Package | TI | |
| Q11-Q13 | 2N3038, Transistors in TO-50 Type Package | TI | |
| C16 | SCM396BP010C2, 39uf, 10 VDC, ±10%, Tantalum Capacitor | TI | |
| C13 | SCH06F221M, 220pf, 200 VDC, ±20%, Ceramic Capacitor | Scionics | |
| C14 | K6G563G-G1, .056uf, 600 VDC, ±2%, Polycarbonate Capacitor | Elpac | |
| C15 | SCM227HP010D2, 220uf, 10 VDC, ±10%, Tantalum Capacitor | TI | |
| C17 | SCM335FP015A4, 3.3uf, 15 VDC, ±20%, Tantalum Capacitor | TI | |

| <u>Component Designation</u> | <u>Description of Components</u> | <u>Manufacturer</u> | <u>Comments</u> |
|------------------------------|---|---------------------|-----------------------------|
| C18 | SCM685BPO35D2, 6.8uf, 35VDC, ±10%, Tantalum Capacitor | TI | |
| Z1 | 1%, IN753, 6.2V, Breakdown Diode, Moly/G Glass Package | TI | Selected from IN753 family |
| Z2, Z5 | 1%, IN752, 5.6V, Breakdown Diode, Moly/G Glass Package | TI | Selected from IN752 family |
| Z3 | 1N969B, 22V, 2% Breakdown Diode, Moly/G Glass Package | TI | Selected from IN969B family |
| D2, D3, D11 D10, D4, D12 | TI-252, 50V, 40ma Diffused Silicon Mesa Diode, Micro/G Package | TI | |
| D7, D8 | G130 Stabistor, Silicon Forward Conductance Diode, Moly/G Glass Package | TI | |
| D9 | G129 Stabistor, Silicon Forward Conductance Diode, Moly/G Glass Package | TI | |
| D11 | TIKD29, 30V, Dual 10 Array, TO-84 Type Package | TI | |
| R1-R3 | RW59G331, 330Ω, 3W, Wirewound Resistor | OMI | |
| R4-R6 | CR-1/8, 442Ω, 1/8W, 1%, Carbon Film Resistor | TI | |
| R7 | CR-1/8, 143Ω, 1/8W, 1%, Carbon Film Resistor | TI | |
| R8 | CR-1/8, 750Ω, 1/8W, 1%, Carbon Film Resistor | TI | |
| R9, R10 | 3260H-1-101, 100Ω, Triptot | Bourns | |

| <u>Component Designation</u> | <u>Description of Components</u> | <u>Manufacturer</u> | <u>Comments</u> |
|------------------------------|---|---------------------|-----------------|
| R11 | CR-1/4, 150Ω, 1/4W, 1%, Carbon Film Resistor | TI | |
| R12 | CR-1/4, 200Ω, 1/4W, 1%, Carbon Film Resistor | TI | |
| R13 | CR-1/8, 100K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R14 | CR-1/8, 150Ω, 1/8W, 1%, Carbon Film Resistor | TI | |
| R15, R20, R21 | CR-1/8, 3.92K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R16 | CR-1/8, 4.99K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R17 | CR-1/8, 2.74K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R18 | CR-1/8, 14.3K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R19 | MC65 T-2, 309Ω, 1/2W, 1%, Metal Film Resistor | TI | |
| R22 | MC65 T-2, 953Ω, 1/2W, 1%, Metal Film Resistor | TI | |
| R23 | CR-1/8, 10K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R24 | CR-1/8, 2.05K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R25 | CR-1/2, 5.23K, 1/2W, 1%, Carbon Film Resistor | TI | |
| R26 | RW69V102, 1K, 3W, Wirewound Resistor | Sprague | |
| R27 | CR-1/8, 3.01K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R28 | CR-1/4, 825Ω, 1/4W, 1%, Carbon Film Resistor | TI | |

| <u>Component Designation</u> | <u>Description of Components</u> | <u>Manufacturer</u> | <u>Comments</u> |
|-----------------------------------|---|---------------------|-----------------|
| R29 | 820Ω, 1/2W, TM-1/4, Sensistor | TI | |
| R30 | CR-1/8, 121Ω, 1/8W, 1%, Carbon Film Resistor | TI | |
| R31, R34 | CR-1/8, 1.02K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R32, R33 | 330Ω, 1/2W, TM-1/8, Sensistor | TI | |
| R35 | CR-1/8, 82.5K, 1/8W, 1%, Carbon Film Resistor | TI | |
| R36 | CR-1/4, 665Ω, 1/4W, 1%, Carbon Film Resistor | TI | |
| <u>Johnson Counter P.C. Board</u> | | | |
| C12 | SCM396BP010C2, 39uf, 10 VDC, ±10%, Tantalum Capacitor | TI | |
| R37-R48 | CR-1/8, 453Ω, 1/8W, 1%, Carbon Film Resistors | TI | |
| N3 | SN5311 Dual 5 Input NAND Gate | TI | |
| N4 | SN5300 J-K Flip-Flop | TI | |
| N5-N7 | SN5302 Dual J-K Flip-Flops | TI | |